

## METHODS AND APPARATUS FOR DETERMINING CARDIAC OUTPUT

### Abstract

[0070] The present invention provides methods and apparatus for determining a  
5 dynamical property of the systemic or pulmonary arterial tree using long time scale  
information, i.e., information obtained from measurements over time scales greater than a  
single cardiac cycle. In one aspect, the invention provides a method and apparatus for  
monitoring cardiac output (CO) from a single blood pressure signal measurement obtained  
at any site in the systemic or pulmonary arterial tree or from any related measurement  
10 including, for example, fingertip photoplethysmography.

[0071] According to the method the time constant of the arterial tree, defined to be the  
product of the total peripheral resistance (TPR) and the nearly constant arterial compliance,  
is determined by analyzing the long time scale variations (greater than a single cardiac  
cycle) in any of these blood pressure signals. Then, according to Ohm's law, a value  
15 proportional to CO may be determined from the ratio of the blood pressure signal to the  
estimated time constant. The proportional CO values derived from this method may be  
calibrated to absolute CO, if desired, with a single, absolute measure of CO (e.g.,  
thermodilution). The present invention may be applied to invasive radial arterial blood  
pressure or pulmonary arterial blood pressure signals which are routinely measured in  
20 intensive care units and surgical suites or to noninvasively measured peripheral arterial  
blood pressure signals or related noninvasively measured signals in order to facilitate the  
clinical monitoring of CO as well as TPR.

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